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The articles to be appeared in the Bulletin must be concise, supplied with experimental methods and data and understandable, without specially referring to the Japaneses texts. It ought, however, not exceed four printed pages as a rule. Any longer articles may be accepted according to the decision of the Council, with or without charge for exceeding pages.

Journal of the Agr. Chem. Soc. of Japan will be published in Japanese as formerly. Those desiring the detailed information of the articles appeared in the Bulletin may look for in the Journal of the same Number or the same Volume.

Editor : Umetarō SUZUKI.
Associate Editors : Kakuji GOTŌ and Yoshihiko MATSUYAMA.

EINE MIKROQUANTITATIVE KOHLENSTOFF (ODER HUMUS) ANALYSE IM BODEN.

Von Munenari TANAKA.

(Aus d. Landwirt. Chem. Institut d. Universität Kyoto.)

(Ausgegangen am 17, Dez., 1926.)

Eine alte, aber sehr genaue Bestimmung des Kohlenstoffgehaltes erfolgte nach G. Logés(1) durch die Verbrennung des Bodens mit Kupferoxyd nach der Makroelementaranalyse. Neulich hat Imai mit seinen Mitarbeitern eine quantitative Kohlenstoffanalyse nach "Verbesserte Chromosäure Methode"(2) ausgeführt. Nach den Angaben von Imai lässt sich der Kohlenstoff in 1$\frac{1}{2}$ Stunden bestimmen, doch da er nur 97% des Kohlenstoffgehaltes angibt, ist die Bestimmung nach seiner Methode keine genaue. Deshalb habe ich Dubsky und Pregl's Methode(3) modifiziert. Durch diese Modifikation gelang es mir, den Gesamtkohlenstoff des Bodens ebenso genau wie nach Loges' Methode zu bestimmen, und zwar noch schneller als nach der Imai's.

Zur Kontrolle der folgenden Methode habe ich zuerst einige reine bekannte organische Substanzen verbrannt. Nach meinen Erfahrungen überschreitet der technische Fehler niemals 0.4 % des enthaltenen Kohlenstoffs: z. B.

7.70 mg. Alizarin ergaben 19.75 mg. CO_2 Ber. 70.1% Gef. 70.0%

Die Ausführung der Analyse ist etwas verschieden, als die bei organischen Substanzen, und es sind besonders die vier folgenden Punkte hervorzuheben:

Erstens. Bei 110°C. getrockneter Boden hat noch sehr viel Wassergehalt, weshalb das gewöhnlich angewandte Mikrocalciumchloridrohr viel zu klein ist. Demnach habe ich ein U Rohr gebraucht, welches dreimal so viel Calciumchlorid enthält als das vorige.

Zweitens. Da der Humus im Boden manchmal nicht einheitlich und gleichmässig vermischt ist, wurde feiner Boden, nachdem er bei 110°C. getrocknet war, im Mörser zerkleinert und innig vermischt. Davon wurden ganz genau 0.02–0.07g. Boden auf dem Schiffchen abgewogen.

Drittens. Der Sauerstoff muss sehr langsam eingeleitet werden, da andernfalls das Wasser ins Natronkalkrohr übergeht. Die Verbrennung ist innerhalb 30 Minuten vollendet.

Viertens. Bei dieser Methode erhält man durch das Wiegen des Bodens nach Verbrennung gleichzeitig den Wert für den Glührückstand. Von vielen

analysen lasse ich hier nur einige, die nach dieser Methode ausgeführt worden sind folgen :

(A) Humus Boden aus Kagoshima

39.45 mg.	Boden ergaben	12.80 mg.	CO_2	Gefunden	8.83%
33.10 〃	〃 〃	10.60 〃	〃	〃	8.73%
42.30 〃	〃 〃	13.62 〃	〃	〃	8.79%

(B) Humus Boden aus Tottori

37.40 mg.	Boden ergaben	12.75 mg.	CO_2	Gefunden	8.86%
37.35 〃	〃 〃	12.20 〃	〃	〃	8.90%

LITERATUR

1) G. Loges : Landw, Vers.—Stat, 28, 229 (1883)
2) Industrial & Engineering Chemistry, Vol. 17, No. 1, Jan, 1925.
3) J. V. Dubsky : Vereinfachte quantitative Mikroelementaranalyse organischer Substanzen 1917.
Fritz Pregl : Die quantitative organische Mikroanalyse 1923.

STUDIES ON YEAST-GUM.

By Yoshitaka HASHITANI.

(From the Laboratory of the Dai-Nippon Brewery Company, Tokyo.)

(Received Jan. 9th., 1927.)

Since 1871 when Béschamp(1) gave his report on the studies of yeast-gum many other investigators as Schützenberger(2), Nägeli and Loew(3), Wegner(4), Hessenland(5) and Lindets(6) have published the result of their researches on the subject. There are, however, more or less evidences that they conducted their experiments on impure samples. It was Salkowski(7) who first isolated the substance in pure state as copper salt and gave it the name by which it is now known. K. Oshima(8), who carried out his experiments on the method of Salkowski, stated that the yeast-gum would produce by hydrolysis, plenty of mannose, small quantity of glucose and a trace of methyl-pentose. Euler considers this result is obtained from pure yeast-gum and I am of the same opinion.

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(1) Béschamp : Comptes rend. de l'Ac., 1871, **72**, 337.
(2) Schützenberger : Comptes rend. de l'Ac., 1871, **78**, 493, 698.
(3) Nägeli u. Loew : Journ. f. prakt. Chemie, 1878, **125**, 403 ; Annalen d. Chemie u. Pharmazie. 1879, **193**, 322.
(4) Wegner : Zeitschr. d. Vereins f. Rübenzuckerind., 1890, **40**, 789.
(5) Hessenland : Zeitshr. f. Rübenzuckerind., 1892, **42**, 671.
(6) Lindets : Comptes rend. de l'Ac., 1891, **112**, 102.
(7) Salkowski : Archiv. f. d. ges. Physiol., 1891, **52**, 554 ; Chem. Contralbl., 1891, 221.
(8) K. Oshima : Zeitschr. f. Physiol. Chemie, 1902, **36**, 42.

Subsequently this subject has been studied by Meigen & Sreng(9), Euler & Fodor(10), and Harden & Young(11). Then Völts & Bandrexel(12) and Simon(13) reported on the effect of yeast-gum on the digestive power of animal body.

For the determination of yeast-gum a typical method is that of Schönfeld & Künzer(14) and Mayer(15), and more recently that of Ling, Nanji & Paton(16).

It should be remembered that yeast-gum is a kind of the so-called mannane and is one of the leading carbohydrates that constitute the yeast cell. The presence of the gum differs much in quantity according to the variety and condition of yeast but in general it is contained in fairly large quantities. It may safely be said that nearly all the soluble carbohydrates found in yeast cell consist of two substances, namely, yeast-gum and glycogen. The relative quantity of the two in yeast cell varies according to the constituents, the density, acidity, and temperature during fermentation of the nutrient solutions, to the presence or absence of oxygen and carbondioxide, and to the quantity and other physical factors of the yeast employed for fermentation.

Therefore, this quantitative relation of yeast-gum and glycogen is a valuable indication not only of the nutritious conditions of the yeast, but of the treatment it has received. At the same time, the relation indicates the vital condition of fermentation and multiplication of yeast. While glycogen serves as a reserve substance of yeast cell, yeast-gum does not appear to be of any such service in this respect and seems to differ very much from the relation in which higher plants stand to mannane. In general, yeast-gum seems to be present in comparatively large quantities in the types of yeast whose fermenting strength is weak. Thus, yeast-gum might be regarded as a kind of worn-out substance. However, judging from the fact that there is such a close association between yeast-gum and yeast-enzymes as to make it quite difficult to separate them for individual preparation, and especially considering that yeast-gum possesses a property closely relating to invertase, I am driven to the conclusion that yeast-gum has a certain important rôle to play in the physiology of yeast.

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(9) Meigen u. Spreng : Zeitschr. f. Physiol. Chemie, 1908, **55**, 48· Centralbl. f. Bakt., 1908, (2), **21**, 769.

(10) H. Euler u. A. Fodor : Hoppe-Seyler Physiol. Chemie, 1911, **72**, 339.

(11) Harden u. Young : Journ. Chem. Soc., 1912. **101**, 1928 ; Chemie Centralb., 1913. **1**, 237.

(12) W. Völtz u. A. Bandrexel : Pflügers Achiv., 1905, **107**, 388 ; Biochem. Zeitschr., 1911, **30**, 457 ; Ibid, 1911, **31**, 355.

(13) F. Simon : Zeitschr. f. Physiol. Chemie, 1912, **77**, 243.

(14) F. Schönferd & E. Künzer : Wochenschr. f. Br., 1914, **2**, 9.

(15) P. Mayer : Biochem. Zeitschr.. 1923, **136**, 487 : through Journ. Inst. Br., 1923. **8**. 667.

(16) A. R. Ling, D. R. Nanji & F. J. Paton : Jour. Inst. Br., 1925. **6**. 316.

Then as the gum has the property to percolate out of yeast cell in consequence of the autolysis of yeast, most likely it will find its way into beer during fermentation and to effect the quality of beer, especially its physical property.

From what has been stated above, it is easy to conclude that the investigation of yeast-gum is of great consequence both from scientific and practical standpoint. For years past I have conducted researches on the "Physiology of Yeast", and will proceed to report here on that part of my studies relating to yeast-gum.

I. METHODS FOR THE DETERMINATION OF YEAST-GUM, AND GLYCOGEN.

In determining glycogen in the yeast, the method hitherto used was a modification of E. Pflüger's process(17) for determining animal constitution, so that the yeast-gum was wholly included in the determination of glycogen. The figures given in former days, therefore, under the name of "Yeast-glycogen", included yeast-gum. It must be noted that under certain conditions, yeast contains greater quantities of gum than glycogen, while our researches have shown that there exists most probably some difference between glycogen and yeast-gum in their physiologycal relation to yeast. From this, it follows that it is necessary to separate these two substances and to effect their distinct determination.

Impressed by that idea I started my investigations years ago and at last devised a process judged suitable for the purpose. It is a happy coincidence interesting to me that the papers by R. Ling, R. Nanji & F. Paton appeared in June, 1925, which came to my hand in September of the year, informed me that they had set about their studies along a similar line and that in many points their investigations agree with mine.

Below will be described the process I have adopted :

About 50 grams of yeast is put in an Erlenmeyer flask to which is added 150c.c. of 66% KOH solution. The mixture is heated for two hours in a hot bath provided with a reflux condenser. After cooling, the mixture is made up to 500c.c. with water and the liquid is cleared by filtration or with a centrifugal separator. Two 100c.c. portions of the clear filtrate are each transferred to a beaker and then alcohol is added. When the alcohol has been concentrated to 60 %, a few drops of saturated NaCl solution is added to precipitate glycogen and yeast-gum. In twelve hours or so, the deposit is filtered off with suction. The resulting precipitate is washed with 60% alcohol, until the filtrate becomes colourless. Washed again two or three times with 95% alcohol, it is dissolved in warm water.

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(17) E. Pflüger: Pflügers Archiv. f. ges. Physiologie, 1909, **129**. 362.

To the one portion of the solution is added HCl to the density of 4% and the mixture is inverted in a hot bath for three hours, and then taken out. After cooling, the solution is neutralized with KOH and made up to 200c.c., of which 25c.c. is used for estimating glucose according to Bertrand's method for determining sugars. The quantity thus obtained was designated as A.

The other portion of the solution is concentrated up to 2% with addition of KOH. By adding further Fehling's solution the copper salt of yeast-gum is precipitated and filtered off about twelve hours later. Well washed with 2% KOH, the precipitate is dissolved in 4% HCl, and washed with HCl of the same strength, till the total volume is made up to about 80c.c. which is inverted in a hot bath for three hours. After cooling, it is neutralized with KOH (which is left off just as the solution begins to get turbid by the precipitation of copper hydroxide) and made up to 100c.c., with water, of which 25c.c. is taken for estimating glucose, according to Bertrand's method. This was designated as B.

The formulae are therefore thus :

$$(2\,A-B) \times 0.9270 = \text{Glycogen.}$$
$$B \times 0.9472 = \text{Yeast-gum.}$$

The coefficient 0.9270 is the figure commonly given to glycogen, while 0.9472 is what we have given to yeast-gum according to my investigations.

II. PREPARATION OF YEAST-GUM.

This was effected mainly on Salkowski's method somewhat modified, details of which are however, omitted here. The yeast-gum thus obtained is a white amorphous and hygroscopic matter which by Fehling's solution forms copper salt but not reduces it. It does not contain nitrogen nor is ash found in determinable quantity. Qualitative reaction, elementary analysis and so forth, prove that the yeast-gum is pure.

III. SPECIFIC ROTATORY POWER OF YEAST-GUM.

Experiments have been made on three different samples of yeast-gum, as to its specific rotatory power, with the Schmidt & Haensch half-shadow polariscope, and the result obtained was as follows :

$$[\alpha]_D^{20°} = 90.59°,\ 90.82°,\ \text{and}\ 90.65°. \qquad \text{mean}: 90.69°$$

IV. FOAMING POWER OF YEAST-GUM.

20c.c. of the aqueous solution of yeast-gum is placed in a bottle for testing hardness of water, and is shaken by hand 100 times. The length of time in which the foam thus produced wholly disappears is compared with that of distilled water similarly treated. It is found that for the 0.05% solution it takes 1–1½ hrs. for the foam to disappear, and 4½–5 hrs. for that of the 0.10% solution, indicating that the time required is 6–8 and 27–30 times as long as that for the distilled water. This shows the strong foaming power of yeast-gum. It may safely be concluded, therefore, that yeast-gum plays an important part in the foaming quality of beer.

V. VISCOSITY OF YEAST-GUM.

The following equation has been obtained from Orth's equation, on the relation between the concentration and viscosity of yeast-gum as experimented by Ostwald's viscosimeter.

$$\log \log \eta = 0.22728 + 0.01380\, x$$

where η is the viscosity of the solution and x is the concentration of yeast-gum.

VI. ELEMENTARY ANALYSIS OF YEAST-GUM.

The elemetary analysis has shown as follows :-

Sample I		0.1839 g.	substance	gave	0.2970 g.	CO_2	& 0.1056 g.	H_2O
Sample II								
	a.	0.2342 g.	″	″	0.3786 g.	″	& 0.1276 g.	″
	b.	0.2324 g.	″	″	0.3795 g.	″	& 0.1292 g.	″
Sample III								
	a.	0.2423 g.	″	″	0.3942 g.	″	& 0.1388 g.	″
	b.	0.2555 g.	″	″	0.4160 g.	″	& 0.1386 g.	″
	c.	0.2241 g.	″	″	0.3622 g.	″	& 0.1286 g.	″

				C %	H %
Found	Sample	I		44.05	6.38
	Sample	II	a.	44.09	6.05
			b.	44.54	6.18
	Sample	III	a.	44.37	6.36
			b.	44.40	6.03
			c.	44.08	6.38
Cal.	$(C_6H_{10}O_5)_n$			44.44	6.17

VII. HYDROLYSIS OF YEAST-GUM.

When hydrolysed with hydrochloric acid yeast-gum produces a large quantity of mannose, a little of glucose and a trace of methyl-pentose, but nothing of fructose, galactose, pentose and the like.

VIII. DERIVATIVES OF YEAST-GUM.

A. Benzoyl derivative. When an alkali solution of yeast-gum is acted upon by benzoyl-chloride drop by drop, benzoyl derivative of the formula $C_6H_8O_5$ $(C_6H_5CO)_2$ is obtained. The substance thus prepared is whitish amorphous and non-hygroscopic, and insoluble in water, ethyl-methyl alcohol, ether, petroleum-ether, and benzene but soluble in pyridine. Its melting point is 223–225°C and decomposes at 240°C.

B. Acetyl derivative. Various experiments were made on this subject and it was ascertained that the largest yield is obtainable when yeast-gum that was treated several times with glacial acetic acid and then with acetic anhydride and anhydrous sodium acetate. The acetyl derivative thus prepared is a white amorphous matter with the formula $C_6H_7O_5(CH_3CO)_3$ and melts at 178–182°C. It is insoluble in methyl-ethyl alchol, ether and benzene, but soluble in chloroform and pyridine.

IX. THE RELATION OF YEAST-GUM TO ENZYMES AND MICRO-ORGANISMS.

Yeast-gum is not in the least affected by the action of such enzymes as Takadiastase, Kashiwagidiastase, digestine, pancreatine and invertase.

Aspergillus, Cladosporium and Penicillium grow on yeast-gum in some measure and it appears to be the case more or less with Mucor and Oidium. But acetic acid bacteria, yeast and the like do not grow at all on yeast-gum.

X. DEPOLYMERIZATION OF YEAST-GUM BY HEATING WITH GLYCERINE.

5 grams of pure yeast-gum mixed with 40 c.c. of anhydrous glycerine is fully stirred up and heated to 210–220°C. for 4–5 hours. The mixture is washed with water into a beaker. After cooling, aceton of about five times as much is added to it, agitated, and left to settle. The aceton layer is then decanted and the sediment is again dissolved in water, and decoloured with animal charcoal. It is precipitated with alcohol. After repeated purification with water and alcohol, the precipitate is finally washed with ether and dried in a dessicator,. yielding 2.5 g. of a substance which possesses the following properties. I consider it as a quite new substance which I named "α-yeast-gum".

A. General Properties of α-yeast-gum. α-yeast-gum is a white amorphous and hygroscopic substance. It is readily soluble in water, but not in alcohol, ether, benzene and aceton. Placed in Fehling's solution, α-yeast-gum forms copper salt insoluble in water, and even when heated it never reduces Fehling's solution.

B. Specific Rotatory Power of α-yeast-gum. I have determined the specific rotatory power of α-yeast-gum, with the following result :

$[\alpha]_D^{20°}$ = 79.55°, 80.49°, 80.19°, mean : 80.08°.

C. Elementary Analysis of α-yeast-gum.

The analysis was as follows :-

Sample I. 0.2574 g. Substance gave 0.4188 g. CO_2 and 0.1484 g. H_2O
Sample II. 0.2416 g. 〃 〃 0.3952 g. 〃 〃 0.1410 g. 〃

		C %	H %
Found	Sample I	44.37	6.40
	Sample II	44.61	6.49
Cal.	$(C_6H_{10}O_5)_n$	44.44	6.17

D. Molecular Weight of α-yeast-gum. The molecular weight has been determined with Beckmann's apparatus and according to the freezing-point method. The results were as follows :

Sample I. 1.0544 g. of α-yeast-gum were dissolved in 8.1800 g. of distilled water and it was found that the depression of the freezing-point of this solution was 0.300°.

Sample II. 1.1438 g. of α-yeast-gum were dissolved in 8.2268 g. of distilled water and the depression of the freezing-point of this solution was 0.330°.

Found

Sample I $$M = \frac{100 \times 1.0544 \times 19}{8.1800 \times 0.300} = 816$$

Sample II $$M = \frac{100 \times 1.1438 \times 19}{8.2268 \times 0.330} = 800$$

Mean $M = 808$

Cal. $(C_6H_{10}C_5)_5$ $M = 810$

E. Foaming Power of α-yeast-gum. Experimented as in the case of yeast-gum, it is found that the foaming power of α-yeast-gum is very weak and its 2–3% solution does not differ much from water in this respect.

F. Viscosity of α-yeast-gum. Experiments have been conducted on viscosity of α-yeast-gum as for yeast-gum to ascertain experimental equation, and following equation was obtained.

$$\log \log \eta = 0.22650 + 0.00921\, x$$

In order to compare the viscosity with that for yeast-gum differential coefficient from both these experimental equations works out thus :

$$\frac{d \log \log \eta}{dx} = 0.00921 \quad \cdots\cdots\cdots\cdots \text{(α-yeast-gum)}$$

$$\frac{d \log \log \eta}{dx} = 0.01380 \quad \cdots\cdots\cdots\cdots \text{(yeast-gum)}$$

G. Hydrolysis of α-yeast-gum. Subjected to hydrolysis by hydrochloric acid, α yeast-gum gives just as yeast-gum a large quantity of mannose, a small quantity of glucose and a trace of methyl-pentose.

II. Derivatives of α-yeast-gum. Treated in much the same manner as yeast-gum, α-yeast-gum gives benzoyl and acetyl derivatives, but no methyl derivative has been obtained. This benzoyl derivative $C_6H_8O_5(C_6H_5CO)_2$ is a white amorphous and non-hygroscopic matter which is insoluble in water, ethyl-methyl alcohol, ether, petroleum-ether, and benzene, but soluble in pyridine, chloroform and aceton. Placed in contact with hot alcohol, it is turned into a substance of semi-liquidity. Its melting point is 198–199°C. The acetyl derivatve $C_6H_7O_5(CH_3CO)_3$ is a light amorphous and non-hygroscopic matter of white or light brown colour. It is insoluble in water, ethyl-methyl alcohol, ether, petroleum-ether and benzene, but soluble in pyridine, chloroform and aceton. Its melting point is 158–159°C.

I. Relation of α-yeast-gum to Enzymes and Micro-organisms.

α-yeast-gum is not affected by such enzymes as Takadiastase, Kashiwagidiastase, digestine, pepsine and pancreatine, but is readily affected by different kinds of fungi, yeast, and bacteria.

From what stated above, it will be seen that α-yeast-gum is a matter wholly different from yeast-gum, in regard to its specific rotatory power, foaming power, viscosity, derivatives and relation to micro-organisms.

XI. YEAST-GUM AS ONE OF THE NORMAL COMPONENTS OF BEER.

Yeast-gum, as stated above, is not affected by the action of various kinds of enzyme, yeast, bacteria, etc., so that the yeast-gum that goes by autolysis of yeast into beer in course of fermentation must be present as a component of beer. Working on that assumption I carried on my researches and succeeded in isolating yeast-gum as copper salt from beer, though the quantity obtained was small. The result was as follows:

		Degree of Balling.	Dextrine in 1000 c.c. beer. (g.)	Yeast-gum in 1000 c c. beer. (g.)	% of yeast-gum for dextrine contents.
Beer soon after Main-fermentation.	A	3.48	17.62	0.02	0.11
	B	3.45	19.04	0 02	0.11
	C	3.45	17.79	0.02	0.11
Beer soon after After-fermentation.	A	2.48	17.02	0.04	0.24
	B	2.90	16.80	0.09	0.54
	C	2.30	17.47	0.09	0.51
	D	2.60	15.91	0.05	0.31

From the above table it will be seen that though of very little content, yeast-gum is always found in beer as its component. Hitherto in the analysis of beer yeast-gum has usually been regarded as dextrine and determined as such. However yeast-gum though present in a very limited quantity, affects the qualtiy, especially physical property of beer, so that its presence in beer, however small in quantity, can not be ignored. Further, as shown in the foregoing table, yeast-gum grows in quantity during after-fermentation up to 2–4 times in the beer that has gone through its main-fermentations. From this fact it may easily be judged that during after-fermentation the yeast by its autolysis exudes various substances in addition to yeast-gum and exerts no small effect on the quality of beer.

XII. CHANGE OF YEAST-GUM IN THE YEAST CELL PLACED IN THE STATE OF STARVATION.

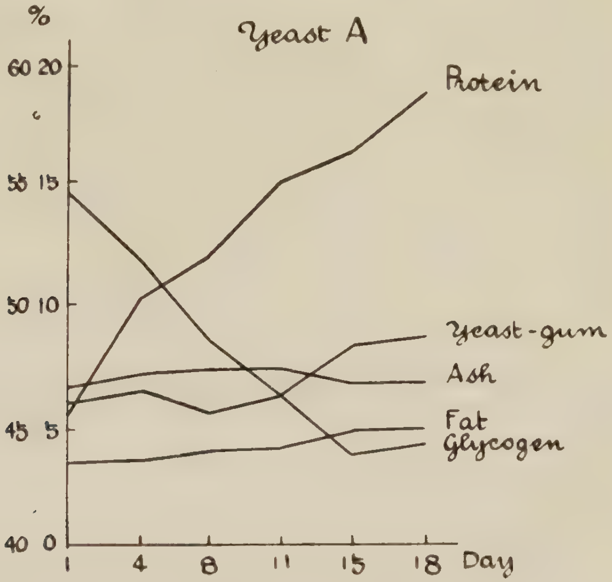
No definite solution has yet been given as to what physiological rôle yeast-gum may play on yeast. In order to attempt this I subjected the yeast long to the state of starvation, depriving it from any nutritive substances, and I then studied how with the change of all other components in the yeast cell during the starvation, the content of yeast-gum goes to vary, and tried also to find indirectly something of the physiological relations in which each component of the yeast cell stands to the yeast.

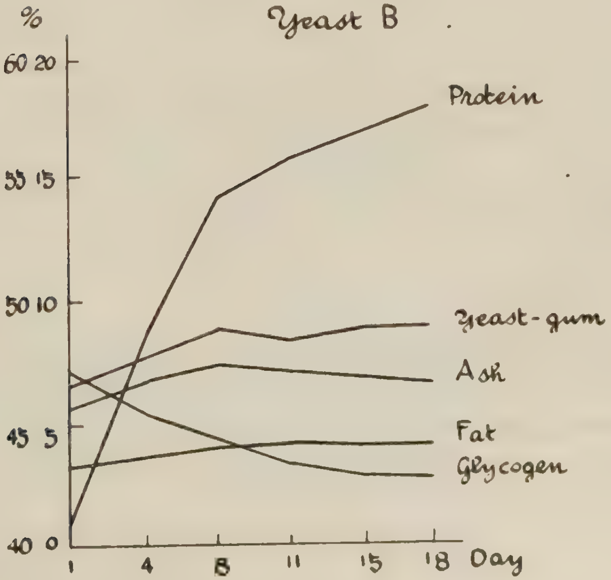
With that object in view, I took a few litres of muddy yeast and washed the sample several times with the clean service-water filtered through a porous pot and let it precipitate the yeast in a large volume of the service-water. It was then stored at a cold place at 2–3°C. Every other day the water was renewed and at a few days' intervals about a litre of the muddy yeast was taken and put through cloth strainer to remove resin. Well washed with water, it was fully filtered with suction to remove the moisture to the atmost, and this sample was used for analysis. The results are tabulated below :

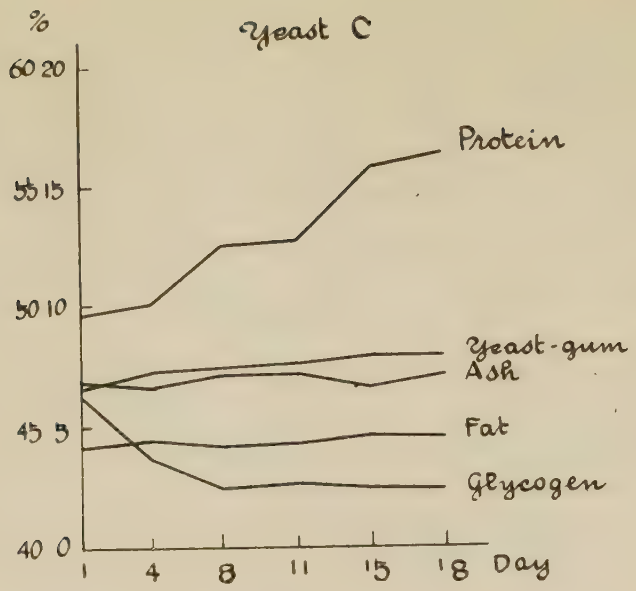
		1st day	4th day	8th day	11th day	15th day	18th day
Yeast A	Sp. gr.	1.5447	1.5133	1.5013	1.4878	1.4827	1.4739
	Protein	45.35	50.14	51.76	54.94	56.34	58.98
	Glycogen	14.48	11.81	8.48	6.31	3.82	4.27
	Yeast-gum	5.81	6.23	5.63	6.03	8.17	8.43
	Fat	3.546	3.772	4.043	4.097	4.901	4.906
	Ash	6.491	6.943	7.125	7.179	6.823	6.836
Yeast B	Sp. gr.	1.4769	1.4852	1.4965	1.4733	1.4712	1.4628
	Protein	40.58	49.39	54.14	55.71	56.93	58.01
	Glycogen	6.96	5.52	4.55	3.39	2.86	2.79
	Yeast-gum	6.66	7.71	8.84	8.19	8.91	8.85
	Fat	3.429	3.676	4.262	4.074	4.042	4.009
	Ash	5.749	6.577	7.143	6.913	6.714	6.507

Yeast C	Sp. gr.	1.5227	1.4832	1.4827	1.4727	1.4745	1.4721
	Protein	49.63	49.94	53.57	53.70	55.75	56.39
	Glycogen	6.18	3.70	2.60	2.70	2.54	2.33
	Yeast-gum	6.66	7.20	7.35	7.55	7.97	7.80
	Fat	4.121	4.454	4.092	4.150	4.660	4.564
	Ash	6.716	6.655	7.030	6.992	6.659	6.949

which is graphically represented in the following:





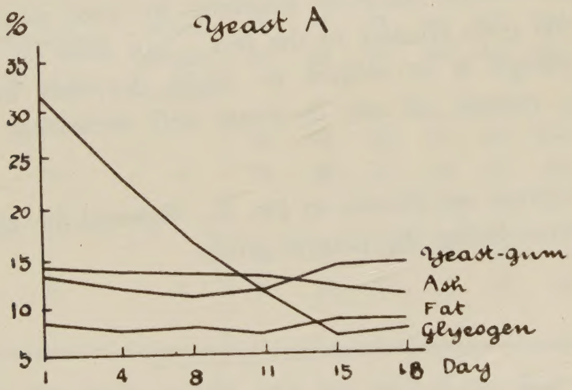


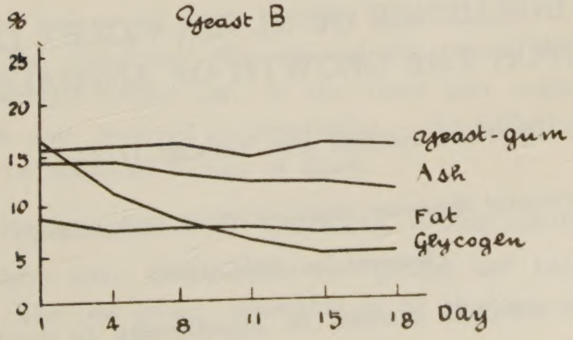
As shown in the graph, except glycogen all the other components have a tendency to grow in percentage, according to number of days during which the yeast was left under starving conditions. When it is remembered, however, that in the present experiments the yeast was cut off from external nutritive substance, there can be no possibility of all the components gaining in quantity during the period. The proper explanation seems to be that the yeast consumes some of its components through autolysis, so that a component found on analysis to have gained in percentage must have done so at the expense of some other components. A question then naturally arises. Is there no change in absolute quantity ? Most probably there is a little decrease. There have recently appeared some reports on the degeneration of yeast, attributing it to the gradual accumulation of protein and fat. This is, however, misleading, for if the components other than those two are left out of consideration, it will merely mean the increase of percentage alone, but not of an absolute quantity.

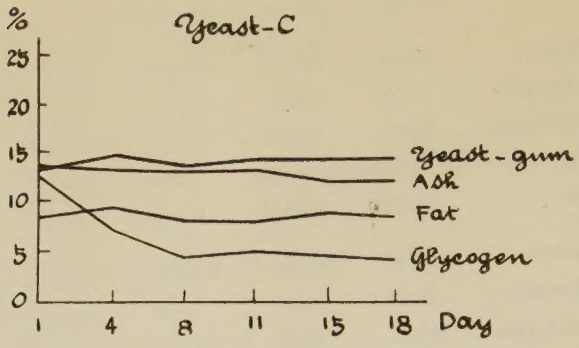
Now protein is the most important component in the life of yeast cell, and as its content is least subject to change, I have taken it as standard of comparison with the index number of 100. To this I have proportioned the other components and worked out what may be regarded as a kind of absolute quantities.

		1st day	4th day	8th day	11th day	15th day	18th day
Yeast A	Protein	100.00	100.00	100.00	100.00	100.00	100.00
	Glycogen	31.93	23.55	16.38	11.19	6.78	7.24
	Yeast-gum	12.81	12.43	10.88	10.98	14.50	14.29
	Fat	7.819	7.523	7.811	7.457	8.699	8.318
	Ash	14.379	13.847	13.765	13.030	12.110	11.590
Yeast B	Protein	100.00	100.00	100.00	100.00	100.00	100.00
	Glycogen	17.15	11.41	8.40	6.09	5.02	4.81
	Yeast-gum	16.41	15.93	16.33	14.70	15.65	15.25
	Fat	8.449	7.596	7.872	7.312	7.099	6.907
	Ash	14.167	14.592	13.194	12.409	11.793	11.211
Yeast C	Protein	100.00	100.00	100.00	100.00	100.00	100.00
	Glycogen	12.45	7.41	4.85	5.03	4.56	4.13
	Yeast-gum	13.42	14.42	13.72	14.06	14.30	13.83
	Fat	8.303	8.918	7.638	7.728	8.358	8.093
	Ash	13.533	13.326	13.123	13.020	11.944	12.323

which is shown graphically in the following:







From the graph we learn that although, according to the nutritious conditions of the yeast, the quantity of each component somewhat changes, yet glycogen alone markedly decreases in any kind of yeast. Thus, it is evident that for yeast during its starvation glycogen is the only carbon source and that it derives its energy from the decomposition of glycogen.

The presence of yeast-gum in yeast is generally in inverse proportion to that of glycogen, being greater when the latter is smaller, but this disparity is very little. It may, therefore, be concluded that yeast-gum lacks its property as a reserve substance, for if otherwise, the yeast containing only a little of glycogen would have to consume its own yeast-gum instead of glycogen, but this goes counter to the fact. Nor does fat present any material variation, though it is subject to slight decrease in yeast with little glycogen. The content of ash in yeast cell somewhat decreases during starvation.

I wish to express my thanks to Dr. K. Makoshi for his valuable advice and kindness given during the present study.

THE INFLUENCE OF ULTRA-VIOLET LIGHT UPON THE GROWTH OF ANIMALS.

By Kozo Suzuki and Tadashi Hatano.

(Imperial Zootechnical Experiment Station, Chiba, Japan.)

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The authors conducted a series of experiments to see the influence of ultra-violet light upon the growth of animals.

1. EXPERIMENTS WITH WHITE RATS.

6 young albino rats, (3♂ and 3♀) almost of the same and approximately of the same weight were divided into 3 pairs, and were kept in wire cages, placed about one metre apart each other in a photographic room where no direct light was admitted, except the rays coming through the small red-glass window of the room.

Their ration was composed as follows: powdered white of egg 16%, starch 67 %, butter fat 12 %, and McCollum's salt (No. 185) 5 %, to which ration was added "oryzanin" in the proportion of 0.5c.c. per rat each day.

The ultra-violet light was radiated by a "Silectra-Standard" quartz mercury-vapor lamp provided with a filter.

The first pair was taken out of the room and irradiated for 15 minutes daily at a distance of 40cm. from the mercury lamp; the second pair was always kept in the dark, but their diet was irradiated for 15 minutes daily at a distance of 10cm. from the lamp; while the third pair was kept in darkness and received non-irradiated diet as a control.

After 56 days, the following results were obtained :-

	Days		0	7	14	21	28	35	42	49	59
1st Pair	Body-weight in grms.	male	28	45	72	95	117	133	150	163	179
(Irradiated Body……)		female	31	48	74	93	107	118	130	140	150
		average									164.5
2nd Pair			32	52	68	91	100	110	125	135	153
(Irradiated Diet …… …)	〃	〃	25	30	40	60	73	78	86	97	105
											129.5
3rd Pair			28	33	42	60	64	73	87	97	100
(Control)	〃	〃	29	33	36	48	49	58	78	87	89
											94.5

We see from the above results that the rats of the first pair which were directly irradiated gained in body weight most rapidly. The second pair which received the irradiated diet showed also much better increases in body weight than the control rats of the third pair which were kept in absolute darkness and received no irradiation. No pathological abnormality could, however, be observed in any of them.

2. EXPERIMENTS WITH CHICKENS, WHITE LEGHORN.

Young chickens were divided into two groups and kept under ordinary diffused lights. The one group consisting of 23 chickens was irradiated for

30 days from the next day of hatch 15 minutes daily, at a distance of 40cm. from the lamp. The ration consisted of: 55 % rice refuse, 7 % wheat, 1 % millet, 25 % fish meal, 3% bone meal, and finely chopped green vegetables.

The control, non-irradiated chickens, did not only grow uniformly, but two of them succombed from malnutrition in 6th and 10th day, respectively; while the irradiated ones grew very well, and none of them died during the experiment. Their average body weights were as follows :-

	0	1	2	3	4	5	weeks
Irradiated Group	38.06	41.93	61.06	94.65	134.76	177.34	grams
Control Group	34.15	37.95	59.16	72.66	102.21	134.71	grams

3. Experiments with Rabbits.

Eight young rabbits were divided into two groups and kept under diffused day light. The ration consisted of: 35% barley, 35% wheat, 30% soy bean cake, besides green vegetable and "tofu" refuse.

The treatment was exactly same with that of the chickens. The irradiation was commenced from 56 days after birth and lasted for 39 days. One of the control rabbit died from malnutrition; while the irradiated animals were all healthy. The average body weights were as follows :-

	0	1	2	3	4	5	weeks
Irradiated Group	215	305	477.5	631.2	762.5	971.3	grams
Control Group	215	282.5	431.0	576.2	680.0	901.0	grams

The above results show that the effect of irradiation was very remarkable, even when the animals were kept under diffused lights. Therefore, the ultra-violet rays present in ordinary day light seem to be far from sufficient for the vigorous development of young chickens. This observation will perhaps throw a certain new light upon the improvement of poultry-raising industry.